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Declaration under Rule 4.17:

— of inventorship (Rule 4.17(iv)) for US only

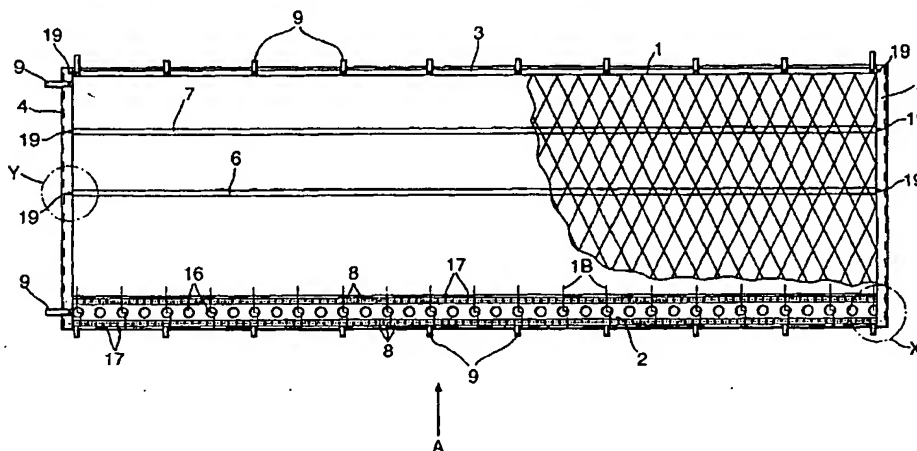
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[Continued on next page]

(54) Title: VEHICLE ARRESTING DEVICE



(57) Abstract: A vehicle arresting device comprises a net (1) intended to be laid flat on the ground in the path A of an oncoming vehicle to be arrested. Two rows of barbed spikes (8) are attached to the net along its leading edge. When a vehicle runs over the device the spikes lodge in its front tyres and the net is caused to wrap around the front wheels, eventually being pulled tight under the vehicle so that the tension in the net prevents further rotation of the wheels and the vehicle is brought to a stop. The net is manufactured such that in its deployed condition it has sufficient lateral stretch to allow it to become fully wrapped around the front wheels before the tension builds up to a level at which there might otherwise be a risk of the spikes being pulled from the tyres.

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For two-letter codes and other abbreviations, refer to the "Guidance Notes on Codes and Abbreviations" appearing at the beginning of each regular issue of the PCT Gazette.

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Vehicle Arresting Device

The present invention relates to vehicle arresting devices, such as may be deployed by law enforcement agencies to safely stop the progress of a suspect vehicle for
5 example if stolen or engaged in other criminal activity.

Vehicle pursuit is one of the most common high-risk areas of law enforcement and many people are killed each year as a result of high speed chases. An alternative method for stopping, or attempting to stop, a fleeing vehicle which is quite widely
10 practised is to deploy on the roadway ahead of the vehicle a device intended to puncture its tyres. A common form of this type of device comprises a lightweight plastics latticework which is laid across the road and carries a number of tubular spikes. When the target vehicle passes over the device some of the spikes
15 penetrate its tyres and are carried along with the vehicle enabling deflation of the respective tyre(s) through their hollow construction. While tyre deflation significantly retards a vehicle and makes it difficult to control, devices of this kind do not necessarily result in the vehicle being stopped, or may do so only after the suspect has been able to continue driving "on the rims" for a considerable distance further.

20 Another form of device intended for more positive arresting of the progress of a vehicle is proposed in US 6220781. This device comprises a panel of lightweight material, such as silk, to be laid on the roadway and having a tactile surface at its leading edge formed from barbed pins and/or adhesive blisters. A split seam extends through the panel from the centre of its leading edge to approximately three-
25 quarters of its length (in the fore and aft direction) and a reinforcement sash of Kevlar® or similar material is affixed to the panel and extends in a partial loop around the split. The intention is that when a vehicle encounters this device its leading edge will adhere to the front wheels so that the panel will wrap around the wheels until, when the limit of the split seam is reached, the reinforcement sash is drawn tight
30 under the vehicle thereby preventing further rotation of the wheels. It is essential to this operation, however, that the vehicle encounters the device with its front wheels disposed either side of the split seam, and important that they run directly over the relatively narrow reinforcement sash in order to ensure that the latter becomes wrapped around the wheels. In other words the operation is sensitive to the correct
35 lateral positioning of the vehicle relative to the device, and it is likely to be successful only where the vehicle can be constrained to pass through a relatively narrow gap where the device is deployed.

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The present invention seeks to overcome the above-mentioned drawbacks of the prior art and in a first aspect resides in a vehicle arresting device comprising a net adapted to be laid flat on the ground in the path of a vehicle to be arrested with one
5 or more transverse rows of upwardly-directed spikes attached to the net at a leading portion thereof, the loops of said net being oriented with a longer dimension in the fore and aft direction than in the transverse direction, whereby in use any widthwise portion of the net is capable of substantial transverse elongation.

10 In a second aspect the invention resides in a method of arresting a vehicle which comprises laying a device according to the first aspect of the invention on the ground in the path of the vehicle such that when the front tyres of the vehicle run over the leading portion of the device one or more said spikes become embedded in each
15 said tyre, the net becomes wrapped around the front wheels of the vehicle, and the portion thereof between the wheels of the vehicle is pulled tight under the vehicle, thereby preventing further rotation of those wheels.

By virtue of the transverse stretchability of the net in a device according to the invention it can readily absorb the loads which are imposed on it as it pulls tight
20 under a vehicle in use of the device, and readily ensure that it is fully wrapped around the vehicle's wheels before pulling tight. Furthermore the device can be effective to arrest a vehicle irrespective of the particular position across its width over which the front tyres of the vehicle run and is not limited in this respect to the critical relative positioning of a split seam and reinforcement sash as in the case of the device of
25 US6220781.

In another aspect the invention resides in a method of constructing a vehicle arresting device according to the first aspect of the invention which comprises: taking a net and deforming the same to elongate the loops thereof in the intended
30 fore and aft direction of the device while reducing the dimension of the net in the intended transverse direction; and attaching elongate elements of flexible material between opposite side edges of the net, whereby to retain the net in such deformed condition when laid on the ground in preparation for arresting a vehicle.

35 In a further aspect the invention resides in a spike assembly for use in a vehicle arresting device comprising a base portion whereby the spike can be stood in an

upwardly-directed orientation, a shaft portion extending from said base portion and a generally pyramidal barb portion at the tip of said shaft portion.

5 These and other features of a vehicle arresting device according to the invention will now be more particularly described, by way of example, with reference to the accompanying drawings of a preferred embodiment thereof and in which:

Figure 1 is a plan view of a preferred form of vehicle arresting device in its deployed configuration;

10

Figures 2 and 3 are respectively a side elevation and an underneath plan view of a typical spike assembly incorporated in the device of Figure 1, to an enlarged scale;

15 Figures 4 and 5 are respectively a side elevation and a top plan view of the spike in the assembly of Figures 2 and 3, to a further enlarged scale, and Figure 6 is a partial section on the line VI-VI of Figure 5;

Figure 7 is a view to an enlarged scale of the region of the device indicated at 'X' in Figure 1;

20

Figure 8 is a section on the line VIII-VIII of Figure 7, to a further enlarged scale;

Figure 9 is a view to an enlarged scale of the region of the device indicated at 'Y' in Figure 1, from beneath; and

25

Figures 10(a) and 10(b) illustrate schematically the configuration of the net incorporated in the device of Figure 1 in its natural woven condition and in the condition in which it is assembled respectively.

30 With reference to Figure 1 there is shown a plan view of a vehicle arresting device in accordance with the invention in its deployed configuration, that is to say laid flat upon the ground with the intention of arresting a vehicle travelling in the direction of arrow A. The device comprises a net 1 of rectangular planform (the mesh of which is illustrated only schematically in Figure 1 but is more accurately depicted in Figures
35 7 and 9). The net 1 is preferably woven from high breaking strain braided polyethylene and is similar in this respect to commercial fishing netting. In the illustrated condition the overall shape of the net is maintained by strips of flexible

material 2, 3, 4, 5, 6 and 7 attached respectively at its leading and trailing edges (in the sense of its orientation to oncoming traffic), side edges and transversely at two intermediate locations. At the leading edge there are two transverse rows of upwardly-directed hardened steel spikes 8, the form of which will be more particularly
5 described with reference to Figures 2 to 6. Tapes 9 are also attached to the strips 2, 3 and 4 at the leading, trailing and one side edge in order to facilitate the manual folding and deployment of the assembled device.

With reference to Figures 2 and 3 each spike 8 is part of an assembly 10 comprising
10 also a perforated steel base 11 welded to the respective spike. The relatively wide base 11 helps to ensure that the spike remains upright when the device is laid on the ground, and is perforated to minimise the weight of the assembly. As shown in Figures 4 to 6, each spike 8 is machined to define a shaft 12 tipped with a sharply pointed, generally pyramidal barb 13. More particularly the barb 13 is polygonal in
15 planform, being machined from a solid cone to provide three major flat faces 13A between three minor frustoconical faces 13B with a common vertex 13C, and is undercut at its base as indicated at 13D in Figure 6. This form of barb with flats 13A machined into a cone has been found to require less force to penetrate conventional
20 tyre rubber than the equivalent plain cone.

Figures 7 and 8 show the relationship of the net 1, spike assemblies 10 and leading edge strip 2. In each row there is a spike 8 located at each alternate knot across the width of the net 1, with the two rows laterally offset from each other by one knot. The spikes are held on the strip 2 at the correct spacing by multiple hook and loop
25 contact fastener material such as that known under the registered trade mark Velcro. Lengths of Velcro® hook material 14 (Figure 8) are sewn to the leading edge strip 2 where the two rows of spikes are required and the spike assemblies 10 are attached by respective pads of Velcro® loop material 15 passing over the spike assembly
bases 11 and into contact with the hook material 14, the pads 15 being apertured to
30 pass the spikes 8. Holes 16 and 17 are shown cut through the material of the strip 2 and (in the case of holes 17) through the associated Velcro® fasteners in Figures 1 and 7 to reduce both the weight of the overall assembly and any aerodynamic forces due to wind acting on the leading edge of the device when deployed.

35 Having attached the spike assemblies 10 to the leading edge strip 2 they are assembled with the net 1 by thrusting the barb 13 of each spike through the respective knot of the net and passing the knot down to engage frictionally around its

shaft 12, as shown for the knot 1A in Figure 8. A plastics tube 18 is passed over the exposed length of each spike 8 to resist lifting of the net along the shaft 12 and to prevent the barb 13 snagging on the net when it is folded for storage and transportation.

5

Figure 9 shows the relationship of the intermediate strip 6, net 1 and side strip 4, the equivalent applying to the opposite side strip 5 and for the trailing edge strip 3 and other intermediate strip 7. The strip 6 comprises a length of webbing which is threaded through loops of the net 1 across its width as illustrated. At each side edge the respective strip 4 or 5 is folded over the net 1 and over the ends of the strips 2 (see also Figure 7), 3, 6 and 7, and glued thereto. To further anchor the side strips 4 and 5 to the ends of the strips 3, 6 and 7 rivets 19 are applied, passing through the material of the respective strips and a local loop of the net. At the leading edge, the side strips 4 and 5 are apertured to pass the outermost spikes 8A, 8B in each row, as shown for the strip 5 in Figure 7.

15

The illustrated device is designed to be man-portable and is normally kept folded in an appropriate backpack, from which it can rapidly be unfolded and deployed across a roadway when a target vehicle is to be arrested.

20

In use, when a vehicle encounters the deployed device from the direction of arrow A in Figure 1, its front tyres will run over a number of adjacent spikes 8 in each of the rows. As a respective spike is encountered the surrounding tube 18 (Figure 8) is crushed down by the tyre, allowing the spike to penetrate the tyre. The barb 13 is shaped to facilitate entry of the spike into the tyre, and its undercut 13D (Figure 6) is designed to catch on the conventional steel braiding within a tyre carcass to resist removal. The net 1 therefore becomes attached to the wheels of the vehicle at two locations across its width, being trapped between the bases of the respective spike assemblies and the tyres in which the spikes are embedded. Continued movement of the vehicle therefore causes the net to wrap around the front wheels and the portion between the wheels is pulled tight under the vehicle until its tension prevents further rotation of the wheels, thereby bringing the vehicle to a stop. In practice this occurs in a similar distance to an emergency stop as if the vehicle's brakes had been applied.

30

It is important to the successful operation of the device that the net 1 has sufficient lateral stretch to absorb the loads that are imposed on it as it pulls tight to arrest a

vehicle, and to allow the net to become fully wrapped around the front wheels before the tension builds up to a level at which there might otherwise be a risk of the spikes 8 being pulled from the tyres. In this respect it will be noted from Figures 7 and 9 that in the initial deployed condition of the device the loops of the net are in a

5 diamond shape with the longer dimension in the fore and aft direction. It is therefore capable of significant lateral elongation before the loops are pulled to a condition in which their longer dimension is in the transverse direction and the net begins to tighten. More particularly, the "natural" form of the loops in which the net is originally woven is rectangular with the longer dimension in the transverse direction, as

10 schematically depicted in Figure 10(a) (where the size of the loops is greatly exaggerated in relation to the overall size of the net for ease of illustration). In the course of assembly of the device, before the strips 2 to 7 are attached, the net is pulled out of the "natural" shape of Figure 10(a) and held in a jig in the less elongate aspect ratio schematically depicted in Figure 10(b) in which it is subsequently

15 retained by the attachment of the strips 2 to 7. Note, however, that the presence of these strips does not prevent the portion of the net between the wheels of a vehicle elongating laterally in use of the device because it is not constrained in that sense by positive attachment to the strips 6, 7 and 3 intermediate its attachment to the side strips 4 and 5, and at the leading edge its attachment to strip 2 is by means of the

20 Velcro® pads 15 over the bases of the spikes 8 which can pull off from the Velcro® material 14 as the net stretches.

It will also be noted that the device can operate to arrest a vehicle as described above so long as both front tyres run over its leading edge, irrespective of the

25 position across the width of the device where this actually occurs.

In order to enhance the initial attachment of the net 1 to the vehicle's tyres its leading edge may be formed with a series of short longitudinal cuts spaced across its width, as schematically indicated at 1B in Figure 1. By this means only the respective

30 section of the net between the adjacent cuts has to be lifted by the tyre during the initial part of its rotation after contacting the spikes 8, which further minimises the risk of the spikes being pulled from the tyre.

CLAIMS

1. A vehicle arresting device comprising a net adapted to be laid flat on the ground in the path of a vehicle to be arrested with one or more transverse rows of
5 upwardly-directed spikes attached to the net at a leading portion thereof, the loops of said net being oriented with a longer dimension in the fore and aft direction than in the transverse direction, whereby in use any widthwise portion of the net is capable of substantial transverse elongation.
- 10 2. A device according to claim 1 wherein said spikes are tipped with generally pyramidal barbs.
3. A device according to claim 2 wherein said barbs comprise a plurality of flat triangular side faces separated by frustoconical side faces.
- 15 4. A device according to claim 2 or claim 3 wherein said barbs are undercut at their bases.
5. A device according to any preceding claim wherein said spikes are comprised
20 in spike assemblies comprising a base portion whereby the respective spike can be stood in an upwardly-directed orientation, a shaft portion extending from the base portion and a barb portion at the tip of the shaft portion.
6. A device according to any preceding claim comprising a plurality of elongate
25 elements of flexible material extending transversely of the net at spaced locations and attached to the net at its opposite side edges.
7. A device according to claim 6 wherein one or more of said elongate elements is threaded through loops of the net between said side edges but more positively
30 attached to the net at said side edges.
8. A device according to claim 6 or claim 7 wherein one or more of said elongate elements is held to the net between said side edges by virtue of separable hook and loop material but more positively attached to the net at said side edges.
- 35 9. A device according to any one of claims 6 or to 8 when appended to claim 5 wherein said spike assemblies are attached to a said elongate element at a leading

portion of the net by means of separable hook and loop material, elements of which material are interengaged with said base portions of respective spike assemblies located therebetween.

- 5 10. A device according to claim 5 or to any other claim when appended to claim 5 wherein said spike assemblies are attached to the net by penetrating respective portions of the net such that the material of the net encircles the shaft portions of those assemblies.
- 10 11. A device according to any preceding claim wherein said spikes are surrounded by respective tubes which are adapted to be crushed to permit penetration of the respective spikes into a vehicle tyre running over such spikes in use of the device.
- 15 12. A device according to any preceding claim wherein said net is formed into a plurality of separate widthwise sections at said leading portion thereof.
- 20 13. A method of constructing a vehicle arresting device according to any preceding claim which comprises: taking a net and deforming the same to elongate the loops thereof in the intended fore and aft direction of the device while reducing the dimension of the net in the intended transverse direction; and attaching elongate elements of flexible material between opposite side edges of the net, whereby to retain the net in such deformed condition when laid on the ground in preparation for arresting a vehicle.
- 25 14. A method according to claim 13 which comprises threading one or more said elongate elements through loops of the net between said side edges but more positively attaching such element(s) to the net at said side edges.
- 30 15. A method according to claim 13 or claim 14 which comprises holding one or more said elongate elements to the net between said side edges by virtue of separable hook and loop material but more positively attaching such element(s) to the net at said side edges.
- 35 16. A vehicle arresting device constructed by a method according to any one of claims 13 to 15.

17. A method of arresting a vehicle which comprises laying a device according to any one of claims 1 to 11 or 16 on the ground in the path of the vehicle such that when the front tyres of the vehicle run over the leading portion of the device one or more said spikes become embedded in each said tyre, the net becomes wrapped
5 around the front wheels of the vehicle, and the portion thereof between the wheels of the vehicle is pulled tight under the vehicle, thereby preventing further rotation of those wheels.
18. A spike assembly for use in a vehicle arresting device comprising a base
10 portion whereby the spike can be stood in an upwardly-directed orientation, a shaft portion extending from said base portion and a generally pyramidal barb portion at the tip of said shaft portion.
19. A spike assembly according to claim 18 wherein said barb portion comprises
15 a plurality of flat triangular side faces separated by frustoconical side faces.
20. A spike assembly according to claim 19 wherein said barb portion is formed by machining said flat faces from a conical form.
- 20 21. A spike assembly according to any one of claims 18 to 20 wherein said barb portion is undercut at its base.

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Fig.2.

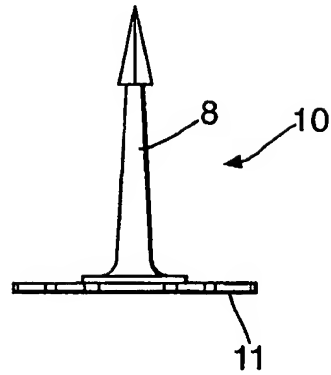
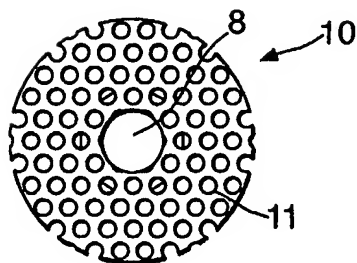


Fig.3.



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Fig.4.

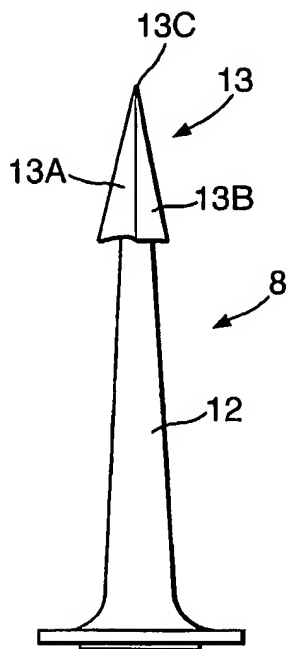


Fig.5.

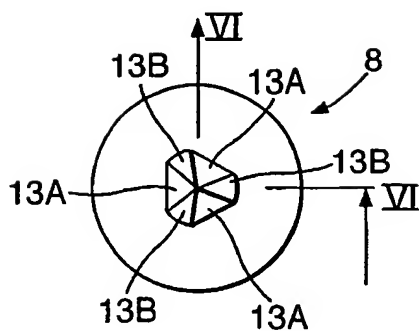


Fig.6.

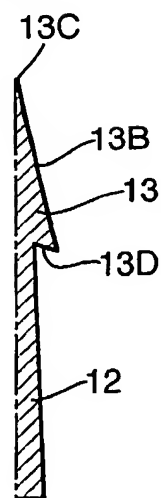


Fig.7.

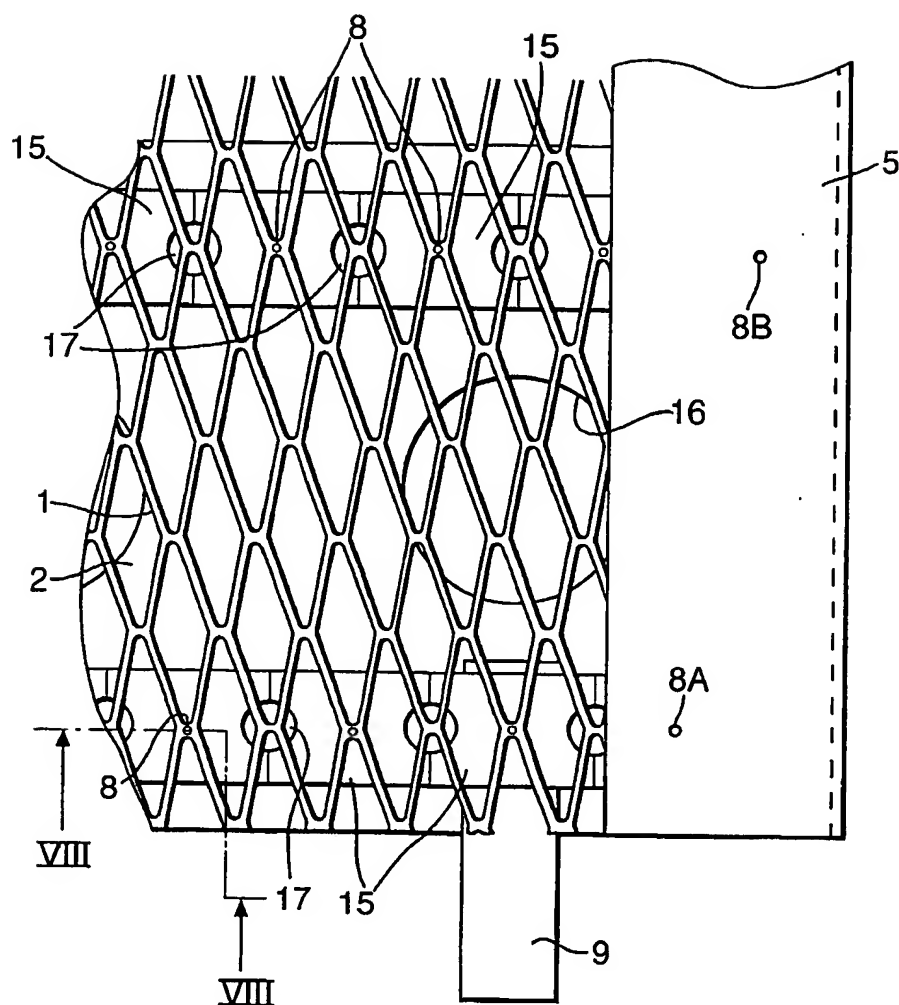
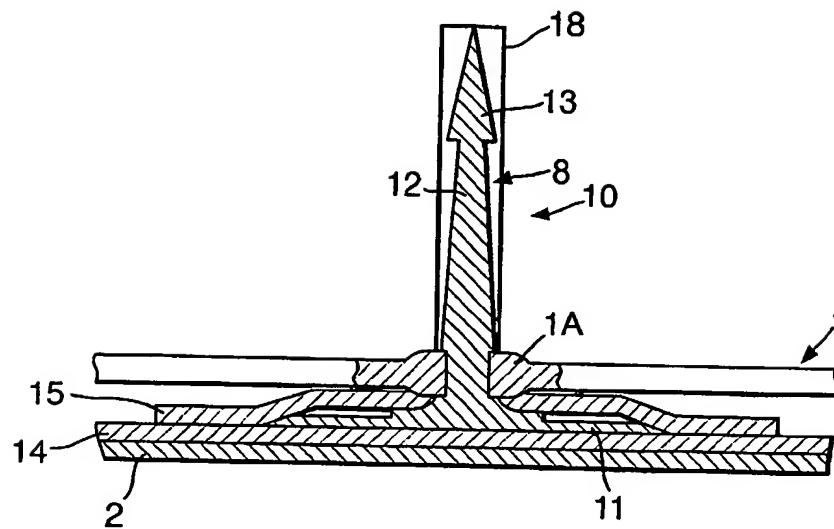


Fig.8.



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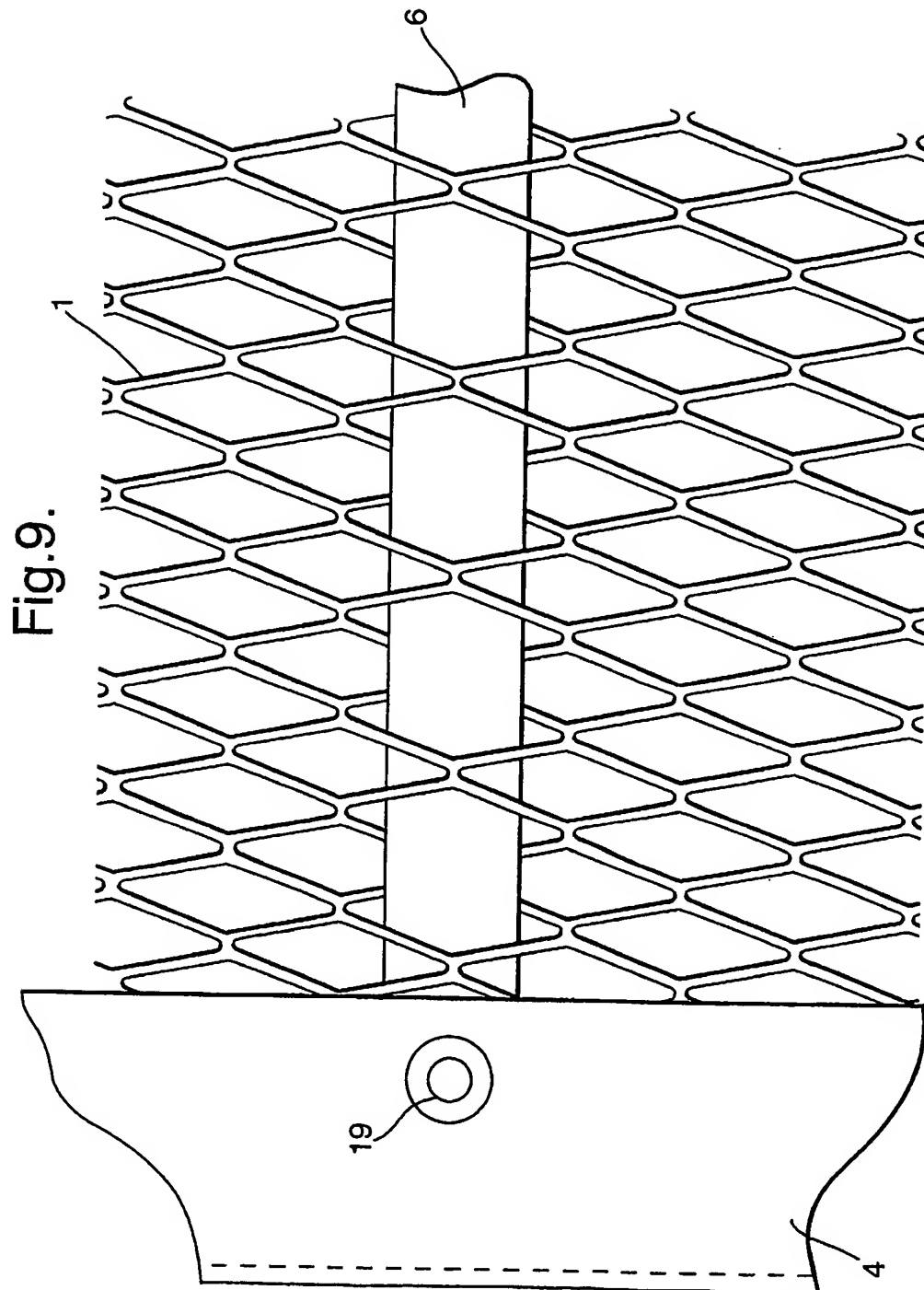


Fig.10A.

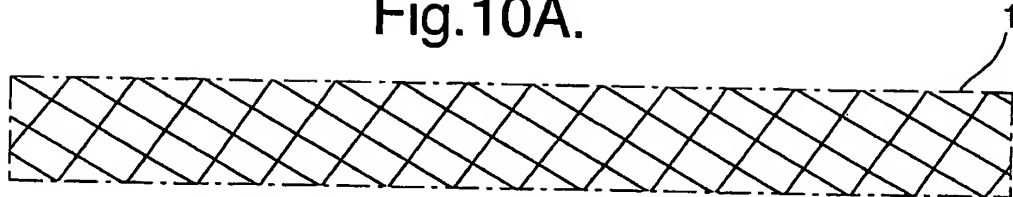
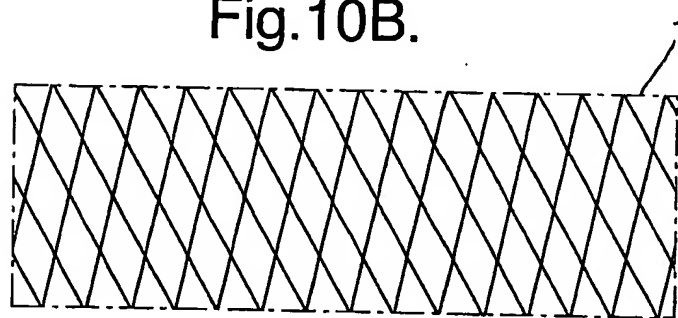


Fig.10B.



INTERNATIONAL SEARCH REPORT

International Application No

PCT/GB2004/000048

A. CLASSIFICATION OF SUBJECT MATTER
IPC 7 E01F13/12

According to International Patent Classification (IPC) or to both national classification and IPC

B. FIELDS SEARCHED

Minimum documentation searched (classification system followed by classification symbols)

IPC 7 E01F

Documentation searched other than minimum documentation to the extent that such documents are included in the fields searched

Electronic data base consulted during the international search (name of data base and, where practical, search terms used)

EPO-Internal, WPI Data, PAJ

C. DOCUMENTS CONSIDERED TO BE RELEVANT

Category *	Citation of document, with indication, where appropriate, of the relevant passages	Relevant to claim No.
X	US 6 322 285 B1 (BEN YOSSI) 27 November 2001 (2001-11-27) column 4, line 66 - column 5, line 8; figures 5,8	18,21
A	-----	1,13,16, 17
A	CA 2 393 380 A (COLLIER ACE R) 8 December 2002 (2002-12-08) page 6, line 1 - line 18 figure 5	1,13,16, 17
X	----- EP 0 280 076 A (DORMET DORFLIGER METALLWAREN) 31 August 1988 (1988-08-31) the whole document -----	18,21

☐ Further documents are listed in the continuation of box C.☒ Patent family members are listed in annex.

* Special categories of cited documents:

- "A" document defining the general state of the art which is not considered to be of particular relevance
- "E" earlier document but published on or after the international filing date
- "L" document which may throw doubts on priority claim(s) or which is cited to establish the publication date of another citation or other special reason (as specified)
- "O" document referring to an oral disclosure, use, exhibition or other means
- "P" document published prior to the international filing date but later than the priority date claimed

- "T" later document published after the international filing date or priority date and not in conflict with the application but cited to understand the principle or theory underlying the invention
- "X" document of particular relevance; the claimed invention cannot be considered novel or cannot be considered to involve an inventive step when the document is taken alone
- "Y" document of particular relevance; the claimed invention cannot be considered to involve an inventive step when the document is combined with one or more other such documents, such combination being obvious to a person skilled in the art.
- "&" document member of the same patent family

Date of the actual completion of the international search

11 May 2004

Date of mailing of the international search report

30.06.2004

Name and mailing address of the ISA

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Geivaerts, D

INTERNATIONAL SEARCH REPORT

International application No.
PCT/GB2004/000048

Box II Observations where certain claims were found unsearchable (Continuation of item 2 of first sheet)

This International Search Report has not been established in respect of certain claims under Article 17(2)(a) for the following reasons:

1. ☐ Claims Nos.:
because they relate to subject matter not required to be searched by this Authority, namely:
2. ☐ Claims Nos.:
because they relate to parts of the International Application that do not comply with the prescribed requirements to such an extent that no meaningful International Search can be carried out, specifically:
3. ☐ Claims Nos.:
because they are dependent claims and are not drafted in accordance with the second and third sentences of Rule 6.4(a).

Box III Observations where unity of invention is lacking (Continuation of item 3 of first sheet)

This International Searching Authority found multiple inventions in this international application, as follows:

see additional sheet

1. ☐ As all required additional search fees were timely paid by the applicant, this International Search Report covers all searchable claims.
2. ☒ As all searchable claims could be searched without effort justifying an additional fee, this Authority did not invite payment of any additional fee.
3. ☐ As only some of the required additional search fees were timely paid by the applicant, this International Search Report covers only those claims for which fees were paid, specifically claims Nos.:
4. ☐ No required additional search fees were timely paid by the applicant. Consequently, this International Search Report is restricted to the invention first mentioned in the claims; it is covered by claims Nos.:

Remark on Protest

- ☐ The additional search fees were accompanied by the applicant's protest.
- ☐ No protest accompanied the payment of additional search fees.

FURTHER INFORMATION CONTINUED FROM PCT/ISA/ 210

This International Searching Authority found multiple (groups of) inventions in this international application, as follows:

1. claims: 1-17

A vehicle arresting device, a use and a method of constructing such a device with a net whereby the loops of said being oriented with a longer dimension in the fore and aft direction than in the transverse direction

2. claims: 18-21

A spike assembly

INTERNATIONAL SEARCH REPORT

Information on patent family members

International Application No
PCT/GB2004/000048

Patent document cited in search report	Publication date	Patent family member(s)	Publication date
US 6322285	B1	27-11-2001	NONE
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